TEST AUTOMATION FOR FUNCTIONAL VALIDATION IN AD APPLICATIONS
From virtual world to real world vehicle testing
11.09.2018 Dr. Björn Butting, Martin Seufert

IPG Apply & Innovate
TEST AUTOMATION FOR FUNCTIONAL VALIDATION IN AD APPLICATIONS

1 | Test & Validation of Autonomous Driving – A Motivation

2 | Seamless Testing for Validation of Autonomous Driving Functions

3 | “Realtime” Test Manager Board

4 | Summary
AUTONOMOUS DRIVING

- “Almost all OEMs offer mass-produced vehicles with automated driving functions”\(^1\)

- "**Testing** remains a focal area for research; **test facilities** being built up worldwide”\(^1\)

- **Testing** in real conditions on **public highway**\(^1\)
  - different countries, different laws, different approval procedures

- **Simulation** as method to **test automated vehicles**
  - 2016: > **3.5 billion virtual km** ⇔ 5 million "real" km physical test cars over the past eight years.\(^1\)

---

\(^1\) Reference: STUDY - Automated Vehicles Index - Q4 2017 - Roland Berger GmbH – Automotive Competence Center & Ika Forschungsgesellschaft Kraftfahrwesen mbH, Aachen January 2018
v_2 = 120 \text{ km/h}

v_0 = 80 \text{ km/h}

v_1 = 80 \text{ km/h}

v_3 = 180 \text{ km/h}

Reference: Prof. Dr. Eric Sax (FZI am KIT) – Testen - Vom Labor auf die Straße und zurück (VDI-Vortrag, Böblingen, Januar 2018)
COMPLEXITY OF DRIVING SITUATION – OVERTAKING (2)

$v_2 = 120 \text{ km/h}$
$v_3 = 180 \text{ km/h}$
$v_1 = 80 \text{ km/h}$
$v_0 = 80 \text{ km/h}$

Reference: Prof. Dr. Eric Sax (FZI am KIT) – Testen - Vom Labor auf die Straße und zurück (VDI-Vortrag, Böblingen, Januar 2018)
Initial Situation: speed of blue truck and orange car is 80 km/h → orange car initiates overtaking maneuver

- $\Delta v$ from 0 km/h to 120 km/h in 10 km/h steps → 12 variants
- $\Delta s$ from 0 m to 100 m in 10 m steps → 10 variants
- Two pairs → $12 \times 12 \times 10 \times 10 = 14,400$ variants for initial situation

Reference: Prof. Dr. Eric Sax (FZI am KIT) – Testen - Vom Labor auf die Straße und zurück (VDI-Vortrag, Böblingen, Januar 2018)
# 2 Seamless Testing for Validation of AD Functions

One Test Strategy & Test Plan to Perform Infinite Hours of Driving Across All Test Levels

<table>
<thead>
<tr>
<th>Level</th>
<th>Test Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>On Road Tests with Target Objects</td>
<td>Vehicle Test Static &amp; Dynamic</td>
</tr>
<tr>
<td>Real Vehicle &amp; Object Simulation</td>
<td>Vehicle- in-the-Loop</td>
</tr>
<tr>
<td>Lab Test Hardware-in-the-Loop, Test Bench</td>
<td>EE System &amp; Integration Test</td>
</tr>
<tr>
<td>Lab Test Hardware-in-the-Loop</td>
<td>Component Test</td>
</tr>
<tr>
<td>Component Test</td>
<td>Virtual Validation</td>
</tr>
</tbody>
</table>

**FASTER, SMALLER, ITERATIVE = MORE AGILE**

**FULL REUSE OF ACQUIRED TEST & MEASUREMENT DATA**
TEST AUTOMATION WITH PROVEtech:TA & SIMULATION WITH IPG CarMaker
BIG DATA: NOT ONLY THE AMOUNT OF DATA

- Amount
- Diversity
- Performance of Data Analysis
- Validity
3 „REALTIME“ TEST MANAGER BOARD

TEST MANAGER BOARD

Test Management Process

Test Level Management Process

Dynamic Test Process

Reference: ISO 29119 + AKKA Digital

Ticket System for Issue Tracking

September 11, 2018  Test automation for functional validation in AD applications, Martin Seufert, Dr. Björn Butting
Test automation for functional validation in AD applications, Martin Seufert, Dr. Björn Butting

On Road Tests with Target Objects

Real Vehicle & Object Simulation

EE System & Integration Test

Lab Test Hardware-in-the-Loop, Test Bench

Component Test

Software-in-the-Loop

Virtual Validation

3 „REALTIME“ TEST MANAGER BOARD

TRACK DOWN THE BUG

BIG DATA
### SEAMLESS TESTING & “REALTIME” TEST MANAGER BOARD

- One test strategy & test plan to perform infinite hours of driving across all test levels
- “Realtime” Test Manager Board

| Classic derivation: Test spec. on base of AD\(^1\) fct. spec. |
| Isolated on each test level |
| Counting test cases |
| Deterministic testing |

Test driving scenes from manoeuvre catalogues
- Seamless over all test levels
- Counting thousands of hours or millions of kms
- “Statistic” validation

---

*FASTER, SMALLER, ITERATIVE = MORE AGILE*

**FULL REUSE OF ACQUIRED TEST & MEASUREMENT DATA**
THANK YOU.

QUESTIONS?